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A deaf person not perfectly skilled in reading words from the lips, or who should ask any thing in the dark would be able to procure common information by putting various questions, and by telling the person that, as he is deaf, he requests answers by signs, which he will direct him to change according to circumstances.—If he had lost his way, if he enquired for any one, if he wanted to purchase any thing, and in all the common occurrences of life, his speech would be so useful, that it would certainly more than repay the trouble of obtaining it; especially as it would be a mode of facilitating every other acquirement.

WILLIAM THORNTON.

N^o. XXXIV.

Observations on the Theory of Water-Mills, (continued from page 193) by W. WARING.

Read, April
5th 1793.

SINCE the Philosophical Society were pleased to favour my crude observations on the theory of mills with a publication in their transactions, I am apprehensive some part thereof may probably be misapplied.

It being therein demonstrated, that, “the force of an invariable stream impinging against a mill-wheel in motion is in the simple direct ratio of the relative velocity,” some may suppose, that the effect produced, should be in the same proportion, and either fall into an error, or, finding by experiment, the effect to be as the square of the velocity, conclude the new theory, to be not well founded; therefore, I wish there had been a little added to prevent such a misapplication, before the society had been troubled with the reading of my paper on that subject; perhaps, something like the following.

The

The maximum effect of an undershot wheel, produced by a given quantity of water in a given time, is in the duplicate ratio of the velocity of the water. For the *effect* must be as the impetus acting on the wheel, multiplied into the velocity of the wheel. But this *impetus* is demonstrated to be, simply, as the relative velocity, [Prop. I. page 146] and the velocity of the wheel producing a maximum, being half that of the water, [by Prop. II. page 147.] is likewise as the velocity of the water: therefore, the power acting on the wheel multiplied into the wheel's velocity, or the effect produced, must be in the duplicate ratio of the velocity of the water. Q. E. D.

Corol. Hence the effect produced by a given quantity of water in a given time, will be as the height of the head, because this height is as the square of the velocity. This also agrees with experiment.

If the force acting on the wheel, were in the duplicate ratio of the water's velocity, as usually asserted, then the effect would be as the cube thereof, when the quantity of water and time are given; which is contrary to the result of experiment.

When I attempted to compute the power, &c. of Doctor Barker's or James Rumsey's mill, as at page 185, the following simple demonstration of its equivalence to that of the undershot wheel, with the same quantity and fall of water, had not then occurred, viz.

Action and re-action are equal, &c.

But the undershot wheel is propelled by the *action*, and the rotatory tube by the *re-action* of the same agent or momentum.

Therefore their mechanical effects must be equal.

The acting and counteracting forces which originate inside the tube, not being from any external impulse, can be no exception; because, in any body, or system of bodies,
the

the mutual actions and reactions of the parts on each other do not alter the motion of their common centre of gravity. [Newt. Princip. B. 1. Law 3. and Corol. 4.]

Hence the increase of power from the centrifugal force, multiplied into the augmentation of velocity thereby occasioned, just equals the force necessary to move the water into its spiral direction; which corresponds with what was before deduced from a different calculus.

Note under the head *Area of the Apertures*, page 192, the resulting equation, which, by inadvertently using a

for 2a, &c. is $\frac{AV}{8.924\sqrt{h}}$ should be $\frac{AV}{18.47\sqrt{h}}$; and, of course, the number 8.924, in rule 4th page 193, should be 18.47; but this oversight does not affect any other part of the calculation.

Philadelphia 4th 4mo. 1793.

Wm. WARING.

N^o. XXXV.

An Improvement on metallic Conductors or Lightning-rods, in a Letter to Dr. DAVID RITTENHOUSE, President of the Society, from ROBERT PATTERSON of Philadelphia.

This Paper was honoured with the Magellanic Premium, by an Award, of the Society in December 1792.

S I R,

Read Nov. 5, 1790.

FROM the instances which now and then occur of houses being struck with lightning, that are furnished with metallic conductors, and the frequent